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Early

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(54) **VACUUM AND GRAVITY DISCHARGE HOPPER CAR GATE**

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(51) **Int. Cl.**
B61D 3/00 (2006.01)

(52) **U.S. Cl.** **105/247**; 105/282.1

(58) **Field of Classification Search** 105/280, 105/282.1–282.3, 247, 248, 253, 286, 288, 105/305

See application file for complete search history.

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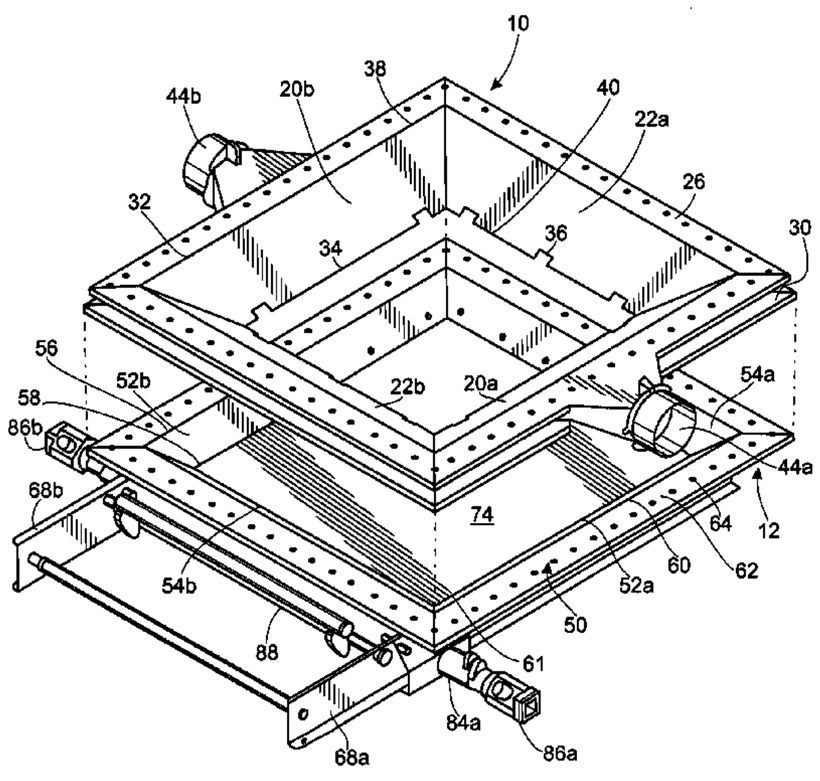
Primary Examiner — Jason C Smith
(74) *Attorney, Agent, or Firm* — Stinson Morrison Hecker LLP

(57) **ABSTRACT**

A hopper car gate having a frame, a moveable door supported by the frame, and a set of walls coupled with the frame. The walls have a lower edge partially spaced above the door, and are positioned to define a vacuum chamber between the walls and the frame. The vacuum chamber is in fluid communication with a vacuum opening formed in the frame. A vacuum adapter configured for mounting on a hopper car gate. The adapter has first and second sets of walls with a vacuum chamber between the sets of walls. The vacuum chamber is in fluid communication with a vacuum opening in the first set of walls.

25 Claims, 20 Drawing Sheets



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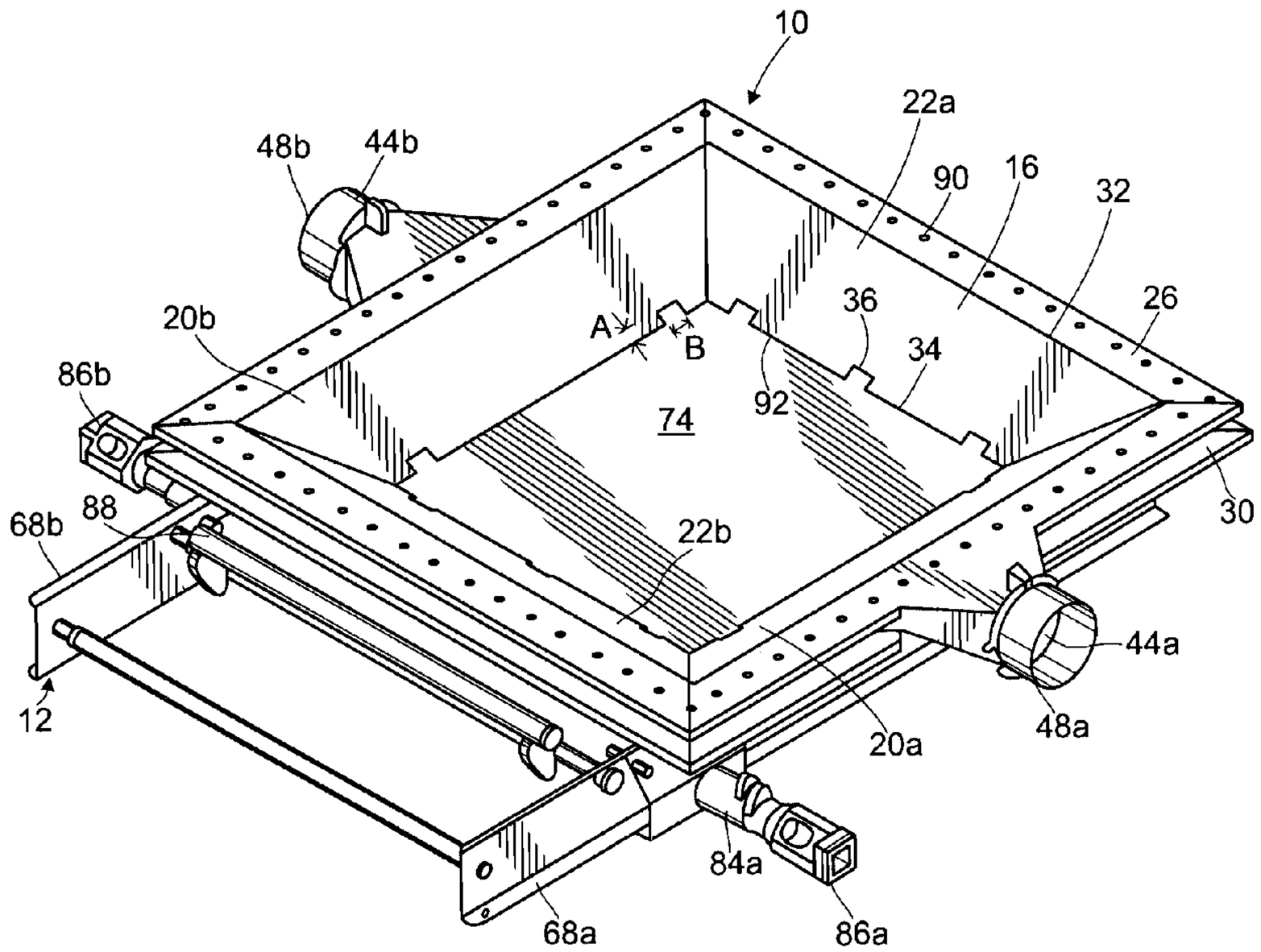
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Fig. 1

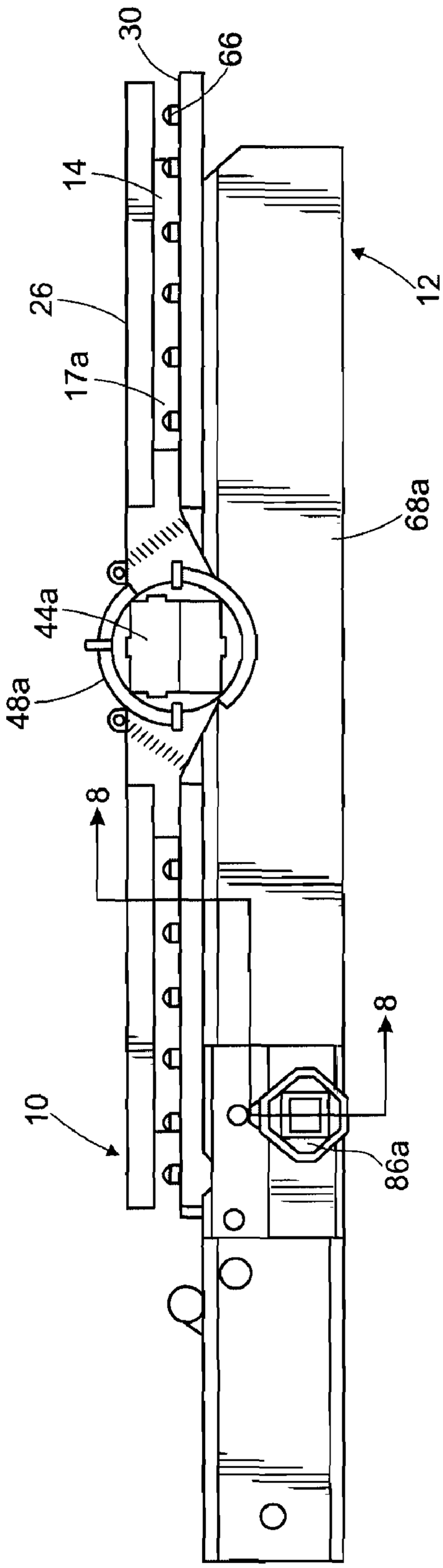

Fig. 2

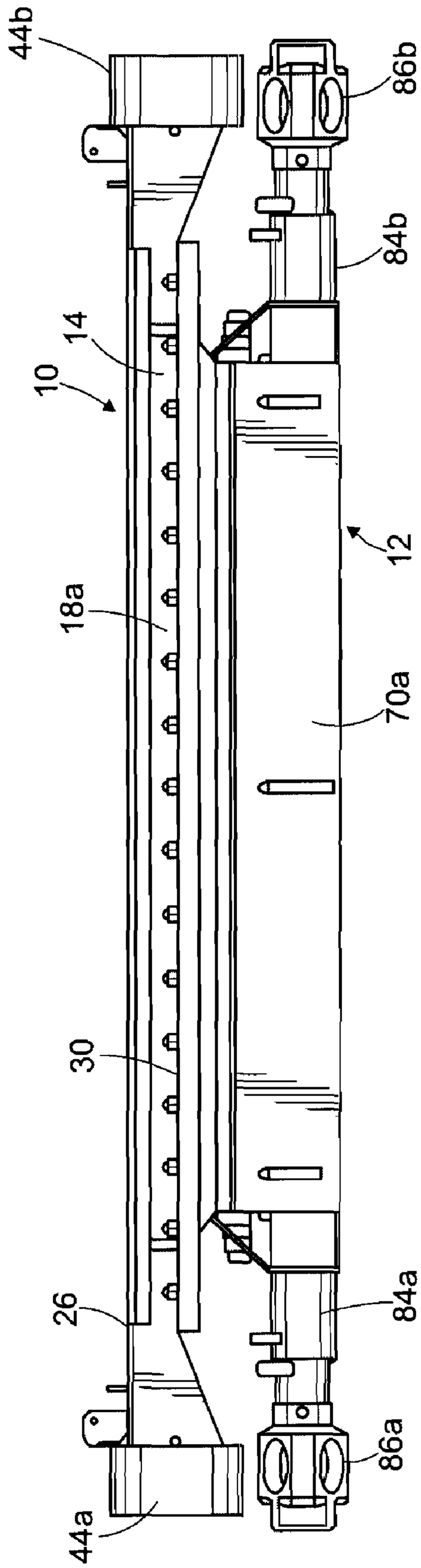

Fig. 3

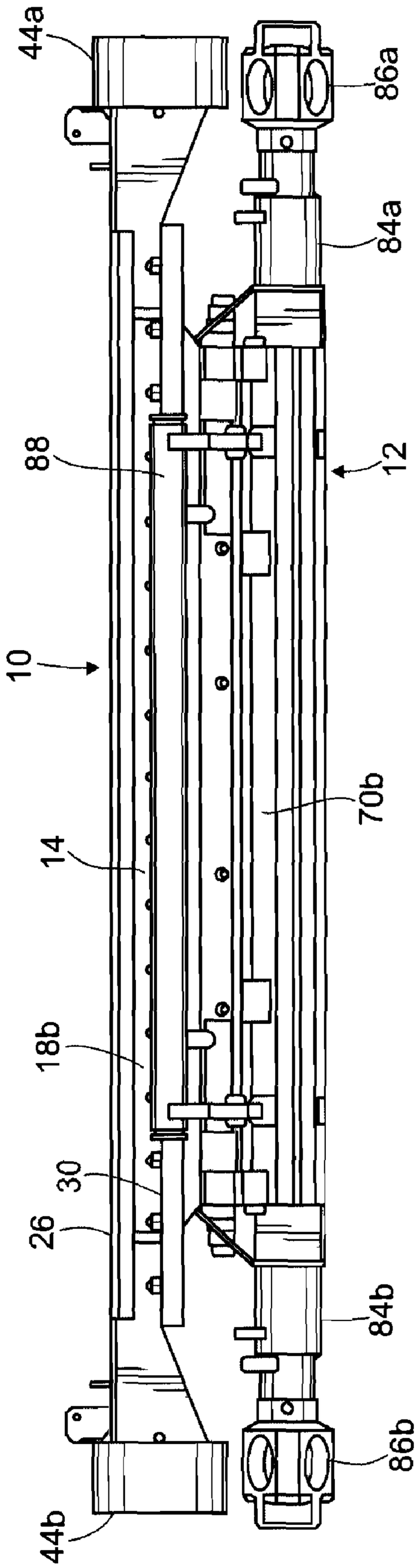

Fig. 4

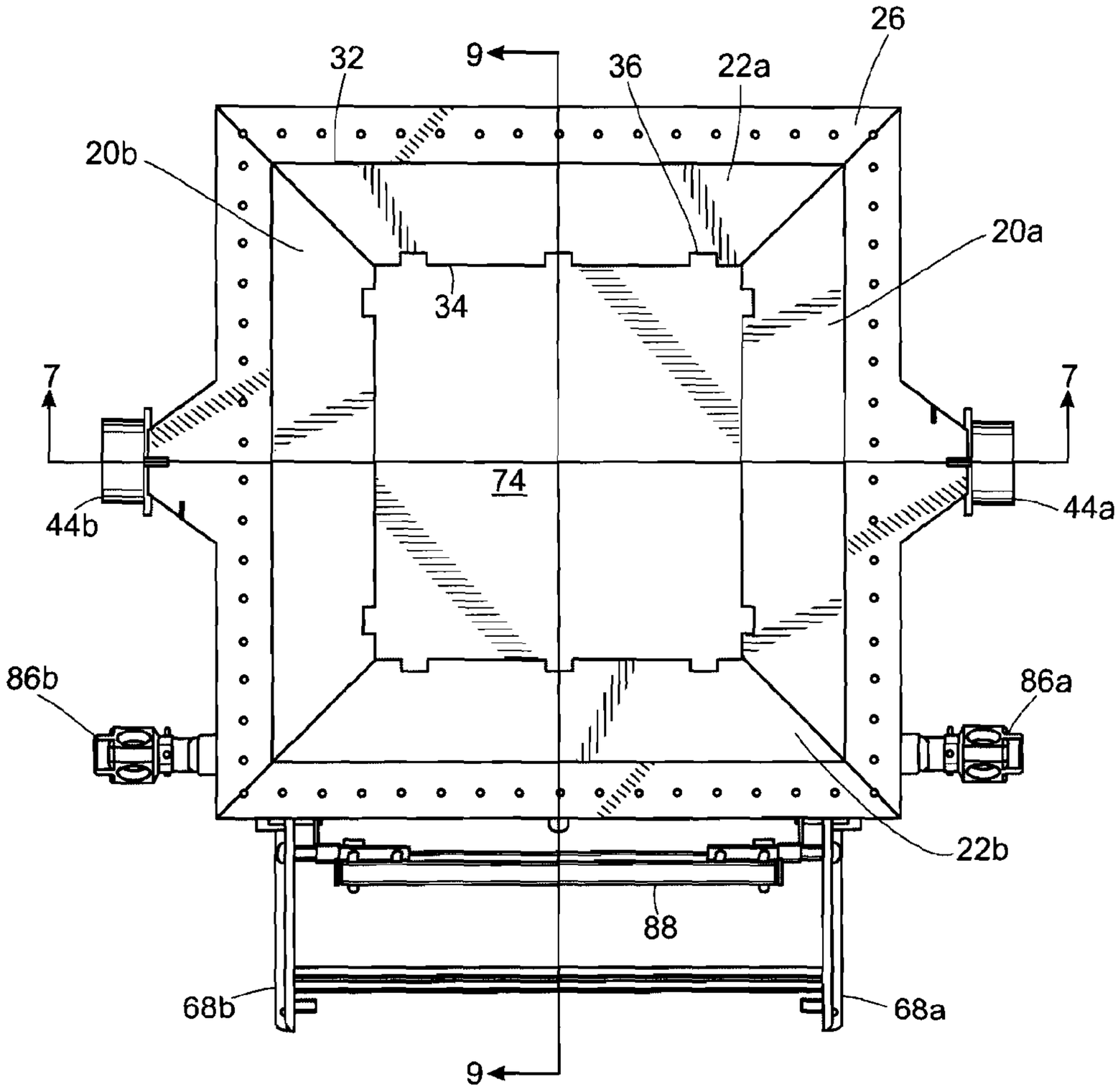

Fig. 5

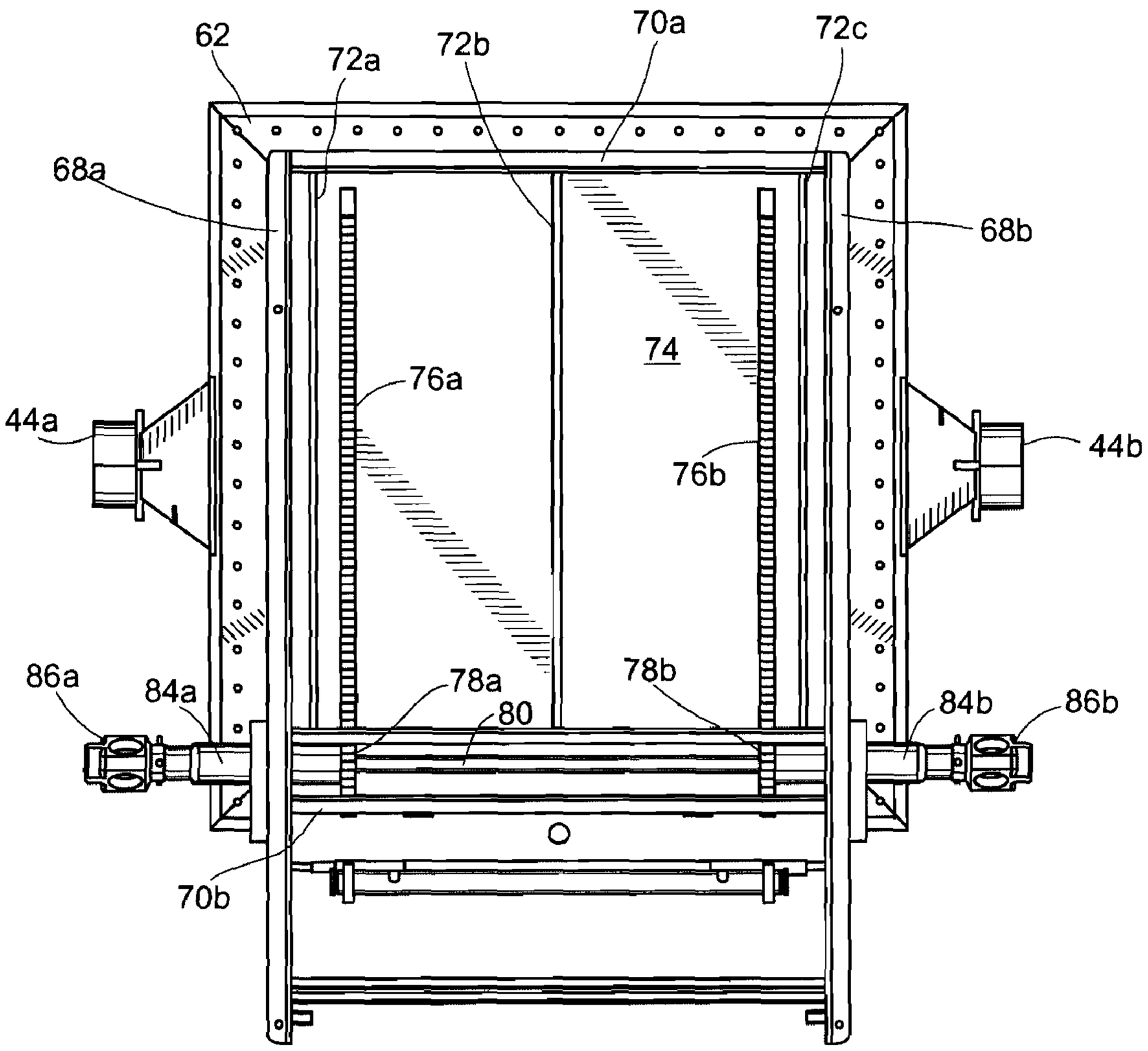
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Fig. 6

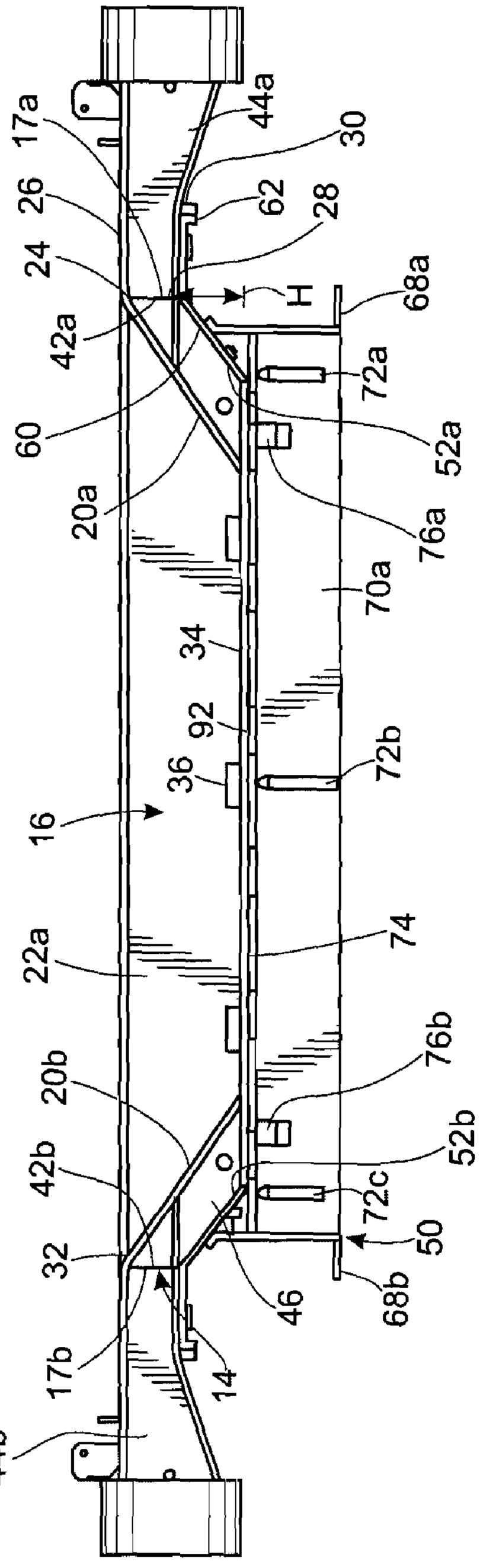
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Fig. 7

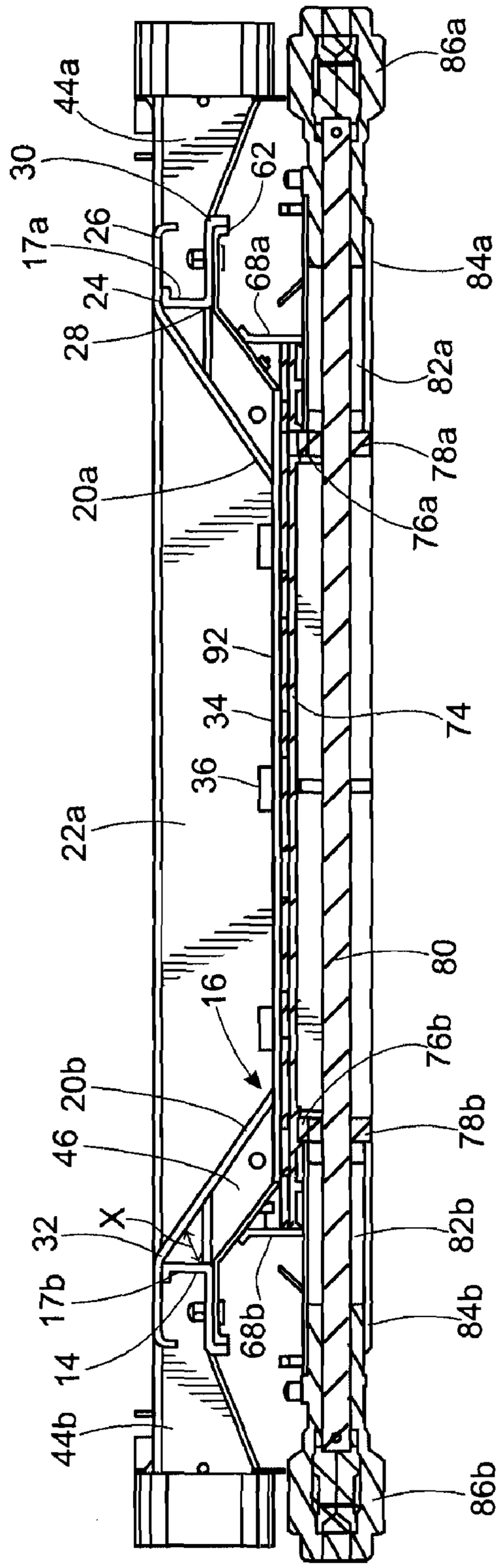
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Fig. 8

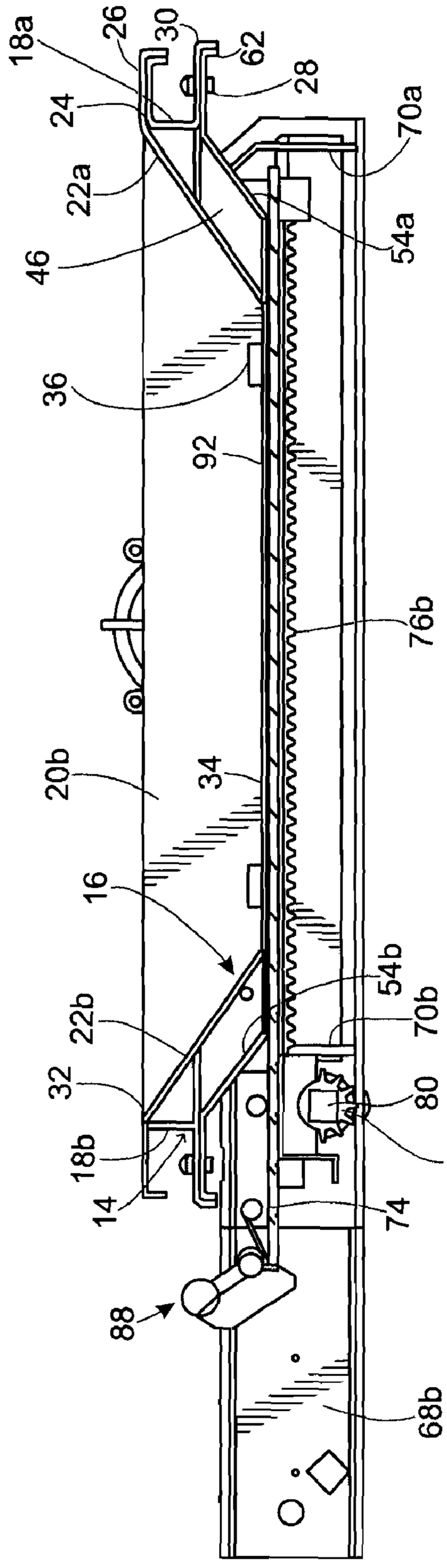
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Fig. 9

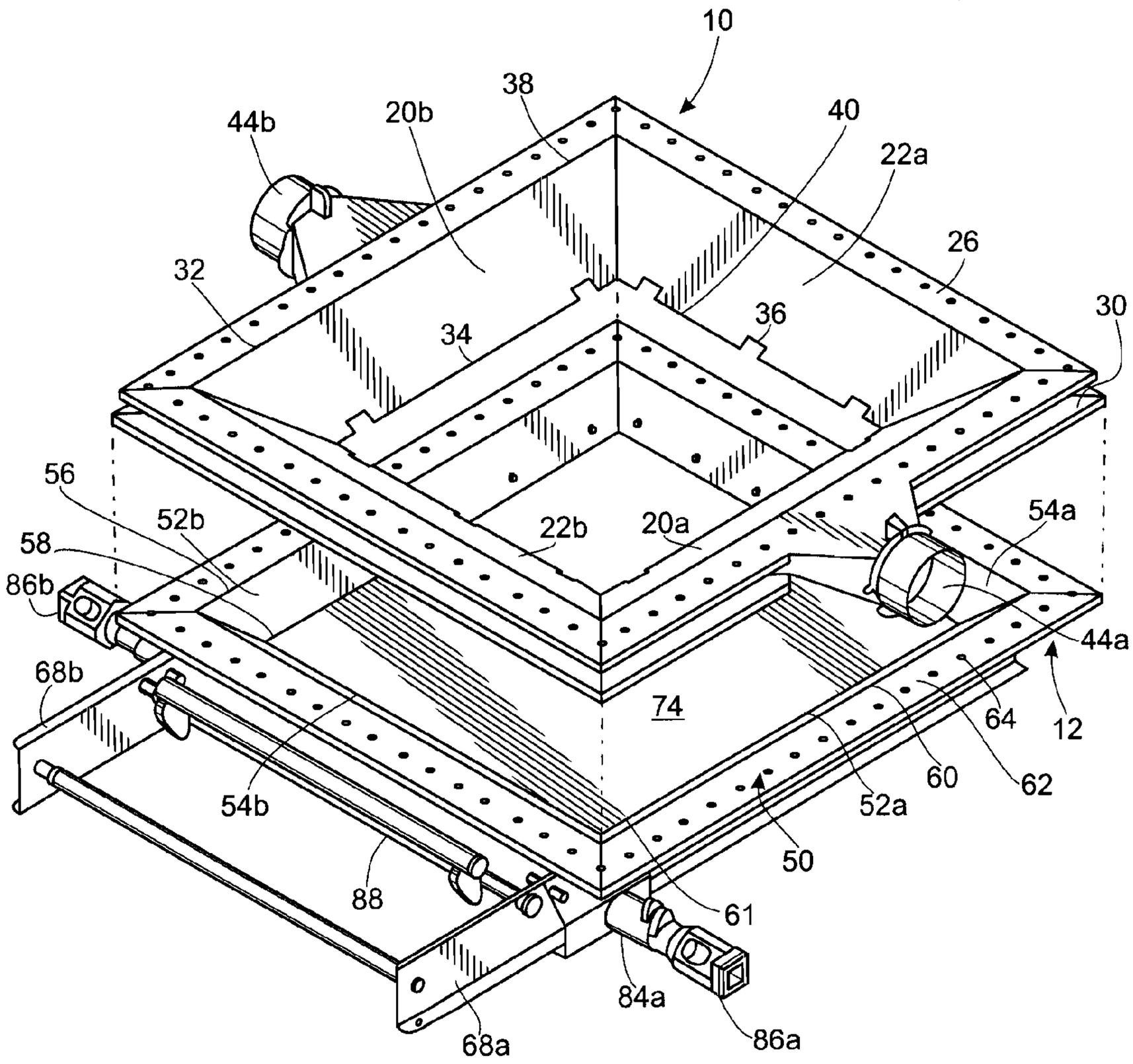
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Fig. 10

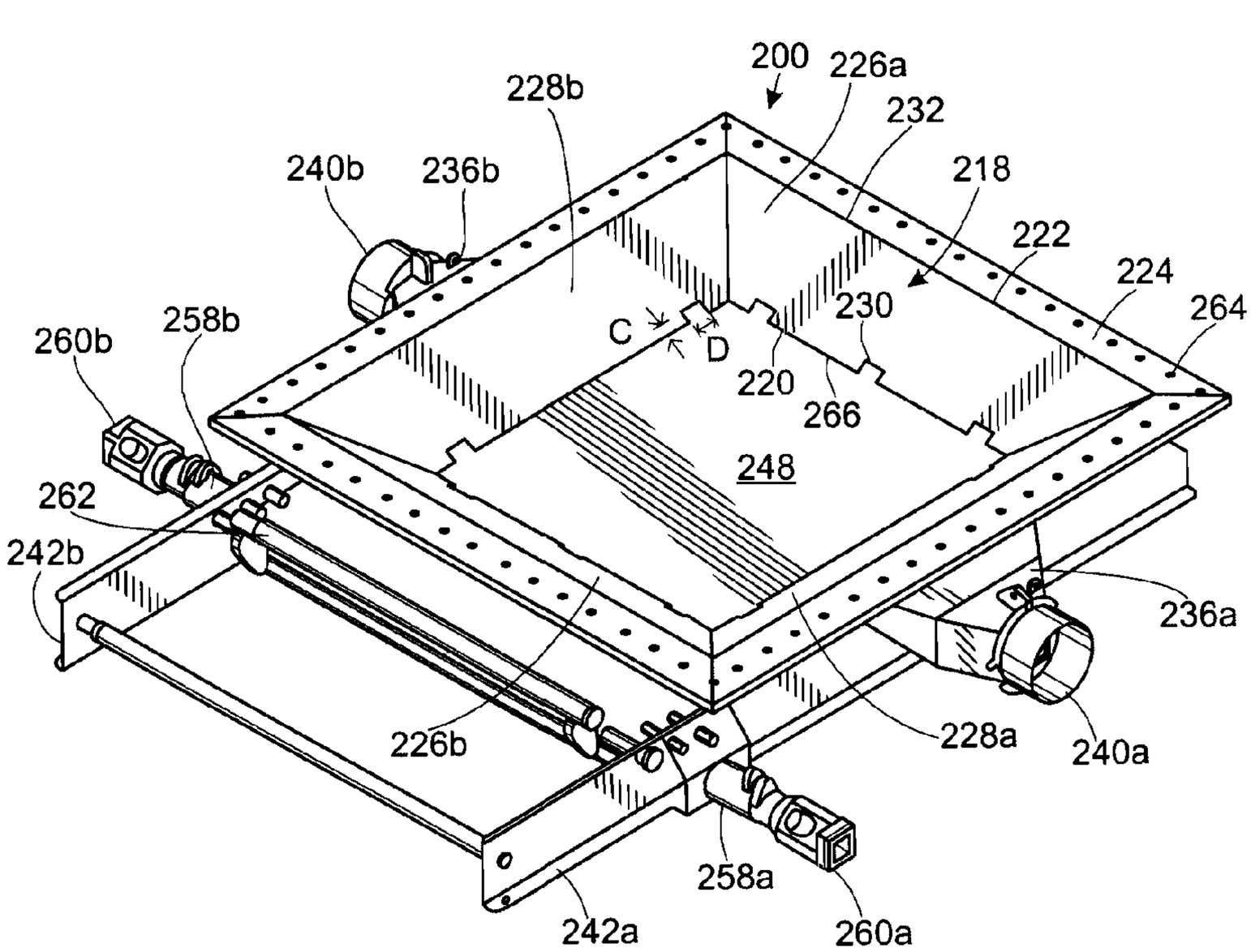
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Fig. 11

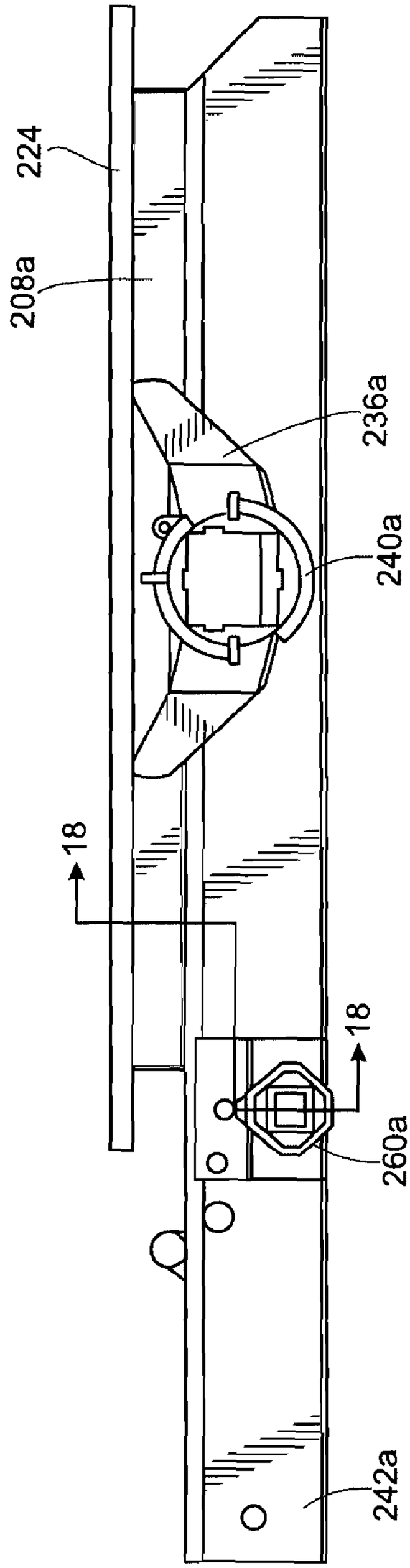

Fig. 12

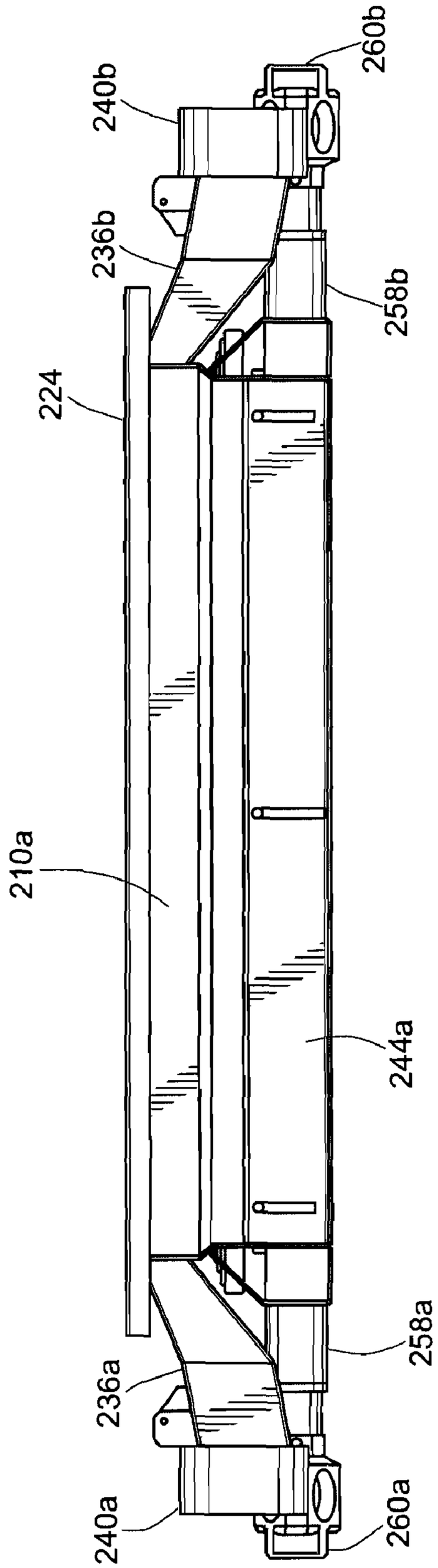

Fig. 13

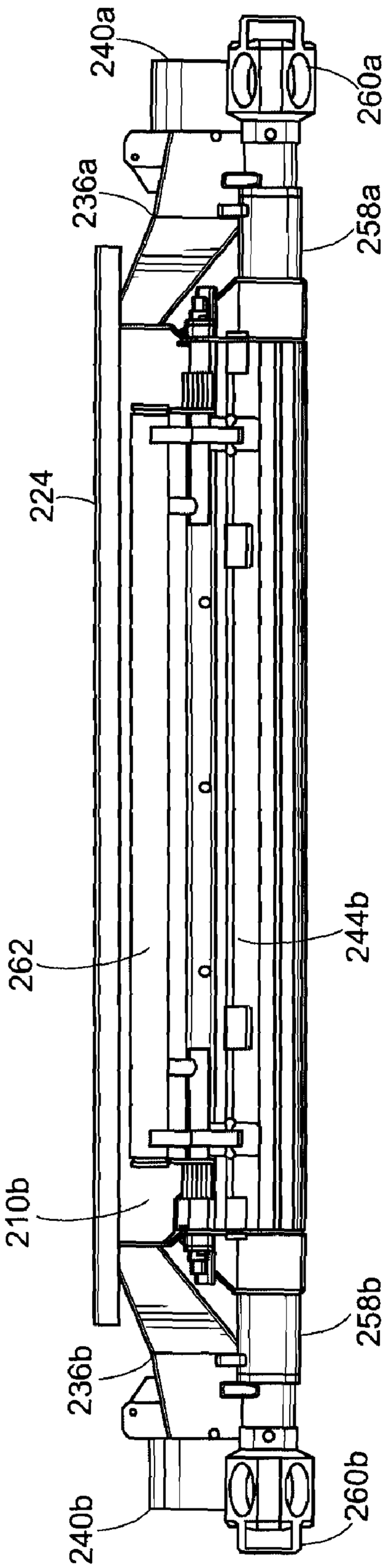

Fig. 14

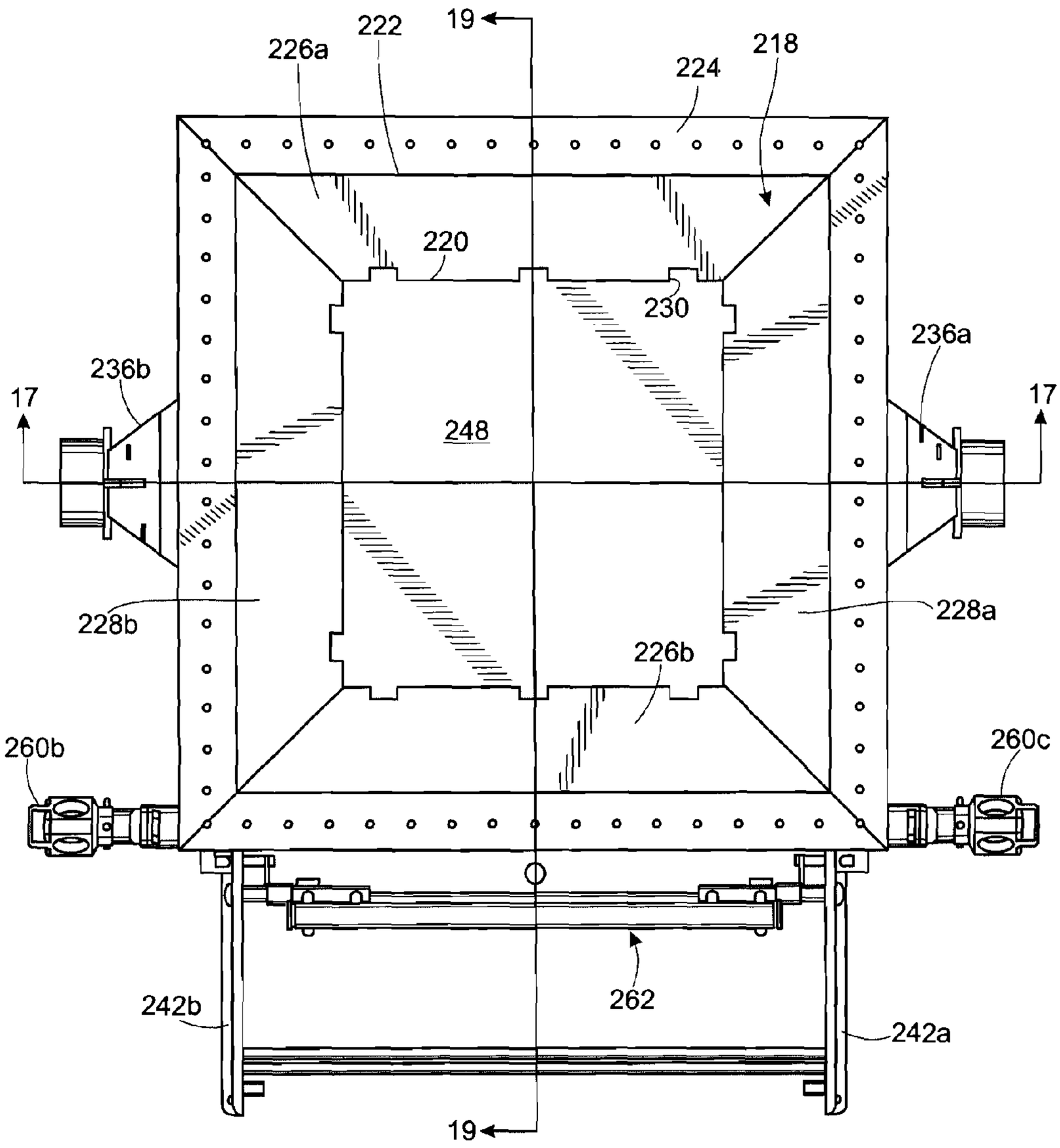
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Fig. 15

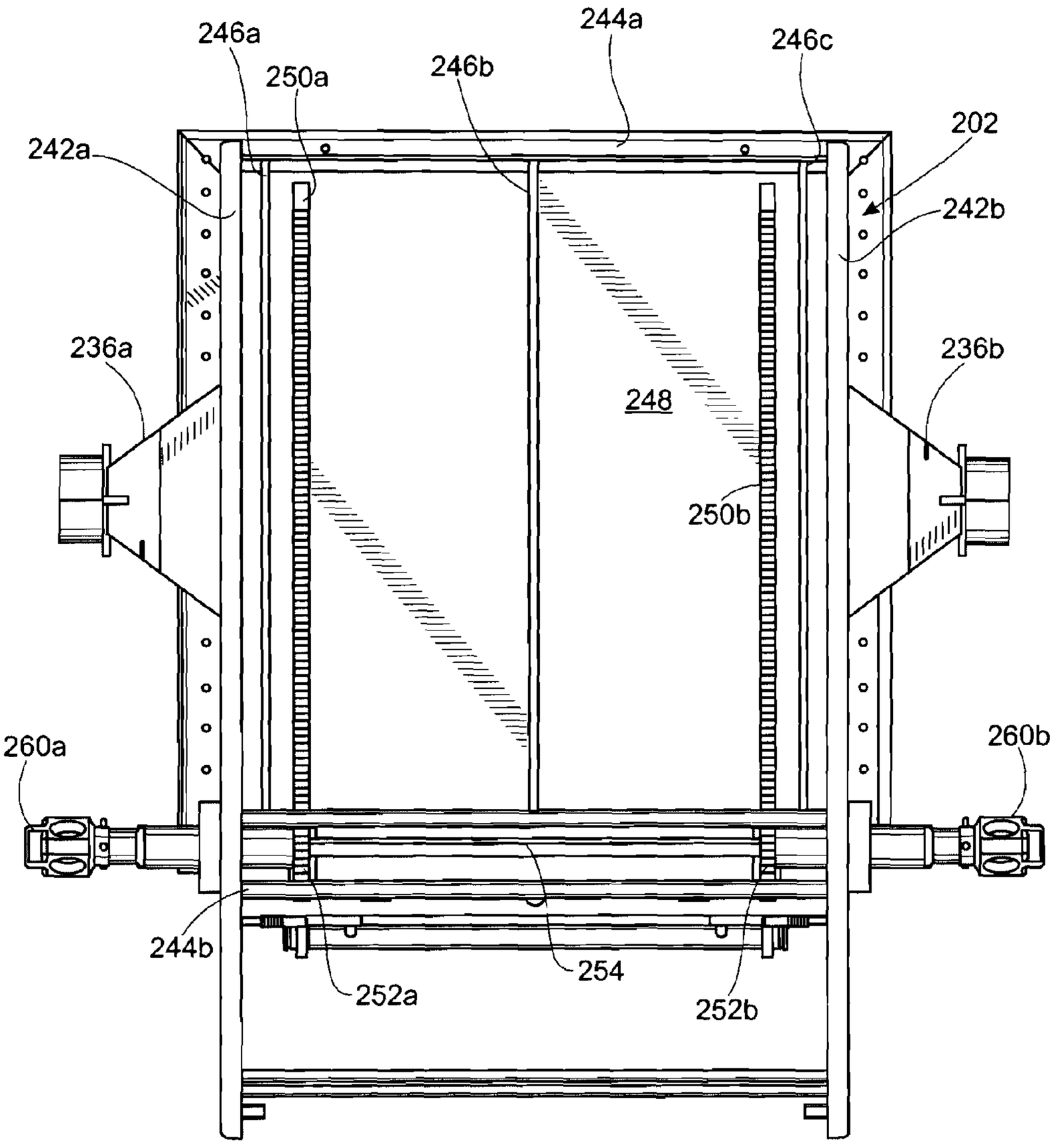
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Fig. 16

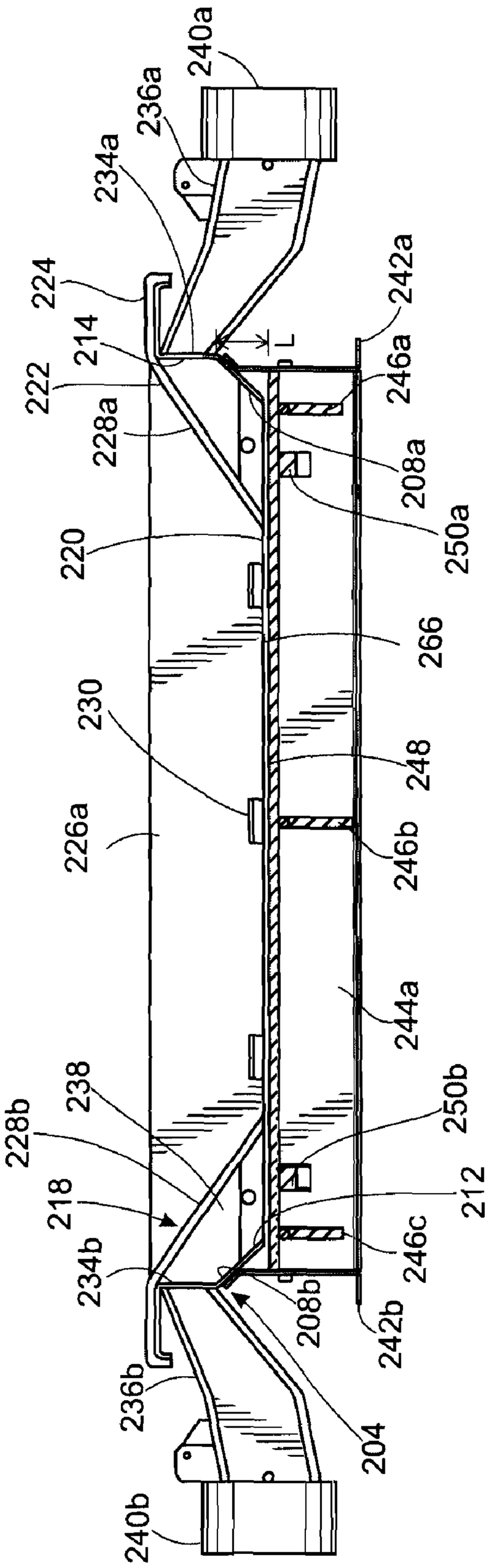
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Fig. 17

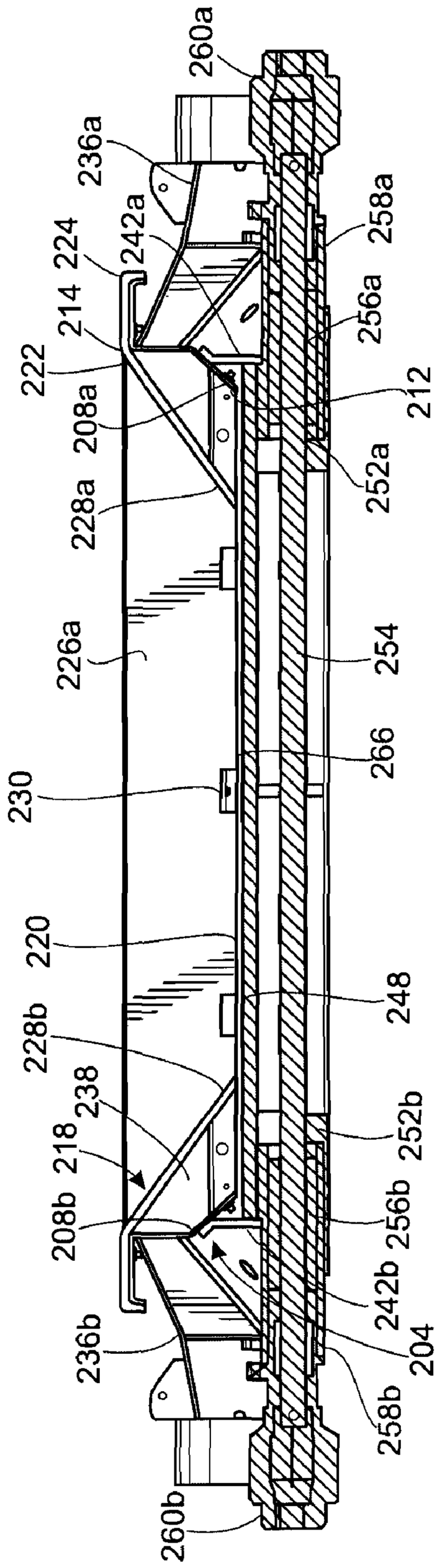
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Fig. 18

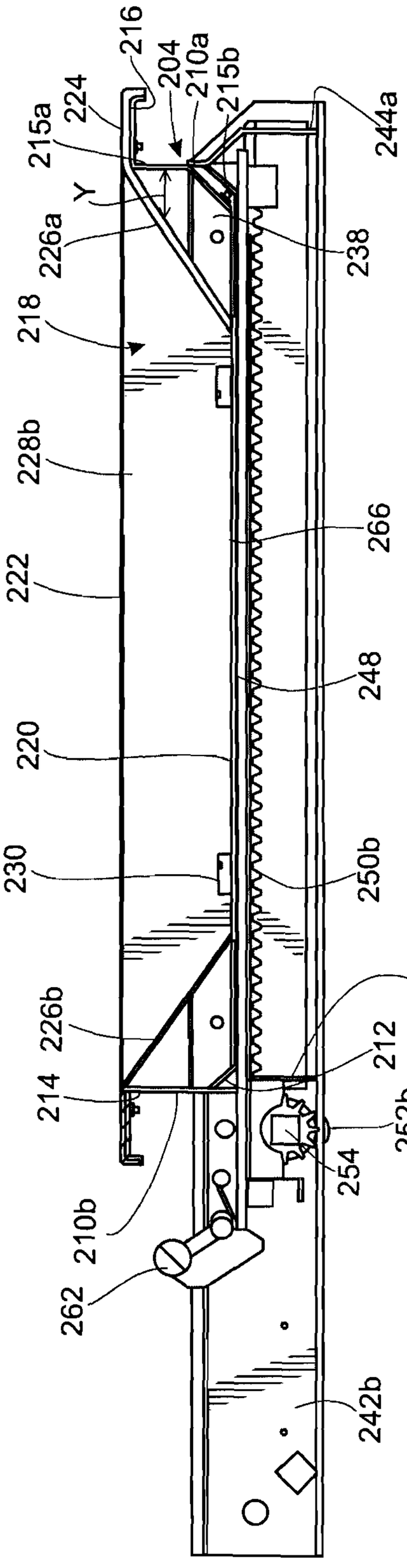
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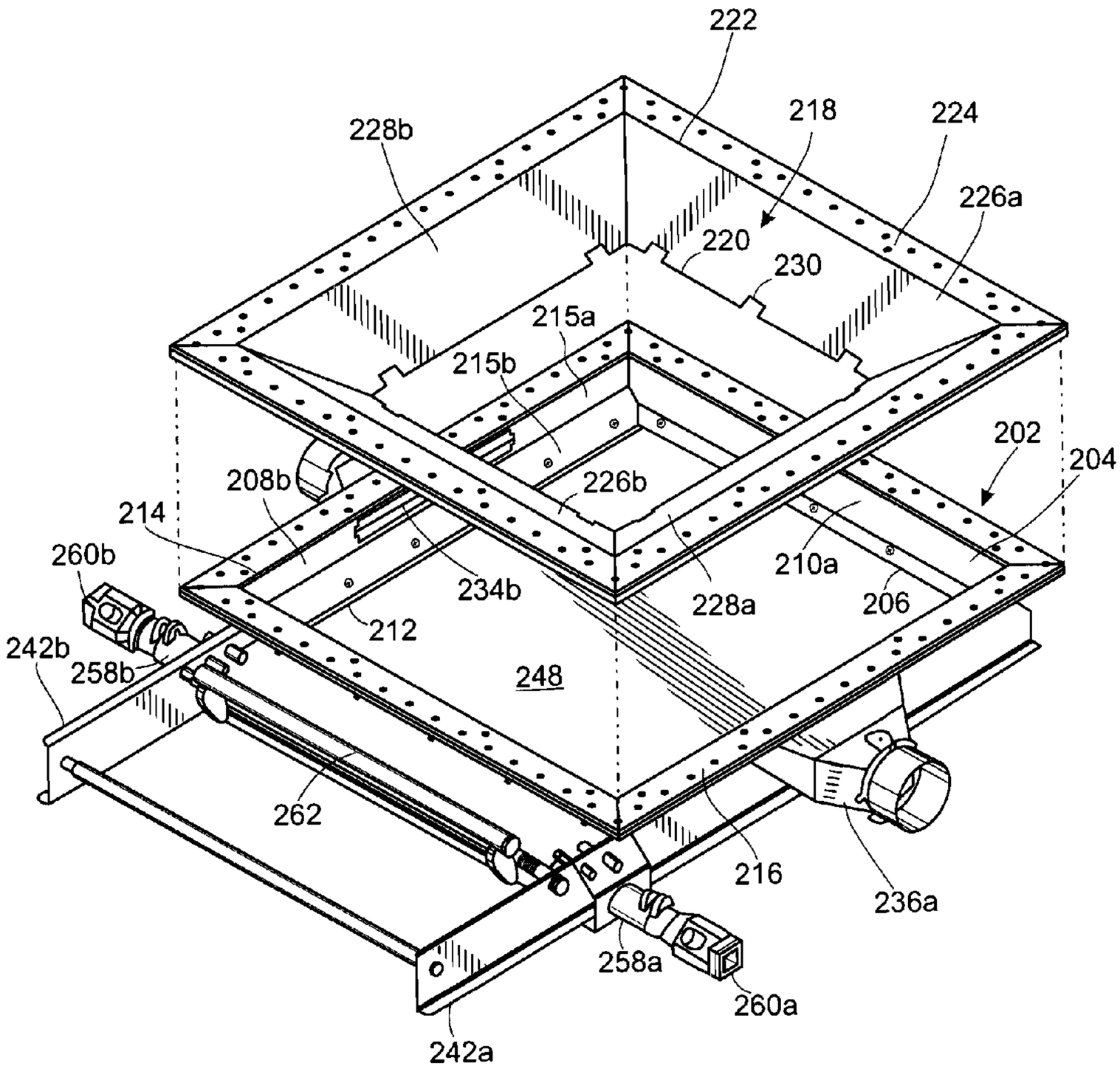
Fig. 19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262
216
236a
258a
260a
242a

Fig. 20

VACUUM AND GRAVITY DISCHARGE HOPPER CAR GATE

CROSS-REFERENCE TO RELATED APPLICATIONS

Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed toward a hopper car gate or a vacuum adapter for a hopper car gate and, more particularly, to a vacuum and gravity discharge hopper car gate or a vacuum discharge adapter for a gravity discharge hopper car gate.

2. Description of Related Art

Conventional hopper car gates that are designed for both gravity and vacuum discharge typically have a frame that supports two vertically spaced doors. The doors have separate opening and closing mechanisms. For gravity discharge, both of the doors are moved into an open position. For vacuum discharge, the top door is moved at least partially to an open position and the bottom door is left in a closed position. A vacuum draws cargo from the volume between the top and bottom doors. While these gates are generally suitable for their intended purpose, they are relatively heavy, expensive, and complex.

BRIEF SUMMARY OF THE INVENTION

A hopper car gate according to one embodiment of the present invention includes a first set of walls including opposed side walls coupled with opposed end walls. A vacuum opening is formed in one of the side or end walls. The first set of walls has top and bottom openings. At least one rail, and preferably two or more rails, extends between and is coupled with the side or end walls adjacent the bottom opening. A door is supported on the rail and is moveable between a closed position that blocks the bottom opening and an open position that allows cargo to exit through the bottom opening. A second set of walls includes opposed side walls coupled with opposed end walls. The second set of walls has an upper edge and a lower edge that is at least partially spaced above the door when the door is in its closed position to present a gap between the lower edge and the door. The second set of walls is coupled with the first set of walls to present a vacuum chamber positioned between the first and second sets of walls. The vacuum chamber is in fluid communication with the vacuum opening.

A vacuum adapter according to another embodiment of the present invention is configured for mounting on a hopper car gate. The hopper car gate has a frame presenting a top opening, a bottom opening, and an upper surface surrounding the top opening. A door is supported by the frame and is moveable between a closed position in which it blocks the bottom opening and an open position in which it allows cargo to exit through the bottom opening for discharging cargo from the hopper car. The vacuum adapter has a flange that is configured for mounting to the upper surface of the gate. The adapter also has first and second sets of walls. The first set of walls has an upper edge and a lower edge that is coupled with the flange. A vacuum opening is formed in the first set of walls. The second set of walls has an upper edge that is coupled with the upper edge of the first set of walls and a lower edge that is at least partially spaced above the door when the door is in its closed position to present a gap between the lower edge and the door. The second set of walls is positioned to define a vacuum chamber between the first and second sets of walls and the frame. The vacuum chamber is in fluid communication with the vacuum opening.

A hopper car gate according to another embodiment of the present invention has a frame defining a discharge opening. A door is supported by the frame and is moveable between a closed position in which it blocks the discharge opening and an open position in which it allows cargo to exit through the discharge opening. A set of walls has an upper edge coupled with an upper edge of the frame and a lower edge that is at least partially spaced above the door when the door is in its closed position to present a gap between the lower edge and the door. The set of walls is positioned to define a vacuum chamber between the set of walls and the frame. The vacuum chamber is in fluid communication with a vacuum opening formed in the frame.

Additional aspects of the invention, together with the advantages and novel features appurtenant thereto, will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following, or may be learned from the practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a vacuum adapter according to one embodiment of the present invention joined to a hopper car gate frame;

FIG. **2** is a side elevational view of the adapter and gate shown in FIG. **1**;

FIG. **3** is a front elevational view of the adapter and gate shown in FIG. **1**;

FIG. **4** is a rear elevational view of the adapter and gate shown in FIG. **1**;

FIG. **5** is a top plan view of the adapter and gate shown in FIG. **1**;

FIG. **6** is a bottom plan view of the adapter and gate shown in FIG. **1**;

FIG. **7** is a cross-sectional view taken through the line **7-7** of FIG. **5**;

FIG. **8** is a cross-sectional view taken through the line **8-8** of FIG. **2**;

FIG. **9** is a cross-sectional view taken through the line **9-9** of FIG. **5**;

FIG. **10** is a partially exploded view of the adapter and gate shown in FIG. **1**;

FIG. **11** is a perspective view of a hopper car gate according to another embodiment of the present invention;

FIG. **12** is a side elevational view of the gate shown in FIG. **11**;

FIG. **13** is a front elevational view of the gate shown in FIG. **11**;

FIG. **14** is a rear elevational view of the gate shown in FIG. **11**;

FIG. **15** is a top plan view of the gate shown in FIG. **11**;

FIG. **16** is a bottom plan view of the gate shown in FIG. **11**;

FIG. **17** is a cross-sectional view taken through the line **17-17** of FIG. **15**;

FIG. **18** is a cross-sectional view taken through the line **18-18** of FIG. **12**;

FIG. **19** is a cross-sectional view taken through the line **19-19** of FIG. **15**; and

FIG. **20** is a partially exploded view of the gate shown in FIG. **11**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

A vacuum adapter according to one embodiment of the present invention is shown generally as **10** in FIG. **1**. As shown in FIG. **10**, the vacuum adapter **10** joins to a gravity discharge hopper car gate **12**. The vacuum adapter **10** includes a first set of walls **14**, shown in FIGS. **2** and **3**, and a second set of walls **16**, shown in FIG. **1**. The first set of walls **14** includes opposed side walls **17***a* and **17***b* (shown in FIG. **7**) each joined with opposed end walls **18***a* and **18***b* (shown in FIG. **9**). Referring to FIG. **1**, the second set of walls **16** includes opposed side walls **20***a* and **20***b* each joined with opposed end walls **22***a* and **22***b*. Referring to FIG. **7**, the first set of walls **14** has an upper edge **24** that is joined with an upper flange **26** and a lower edge **28** that is joined with a lower flange **30**. As shown in FIG. **1**, the second set of walls **16** has an upper edge **32** that is joined with upper flange **26** and a lower edge **34**. Referring to FIG. **8**, there is an angle X between the first and second sets of walls **14** and **16**. The angle X is preferably between approximately 30 to 60 degrees.

A plurality of notches **36** are formed in the lower edge **34** of walls **16**. As shown in FIG. **1**, there are three notches in each of end walls **22***a* and **22***b* and two notches in each of side walls **20***a* and **20***b*. It is within the scope of the invention for there to be more or less notches **36** than those shown in FIG. **1**. The notches **36** preferably have a height A of between approximately 0.5 to 3 inches, and a width B of between approximately 1 to 4 inches. Referring to FIG. **10**, the adapter **10** has a top opening **38** and a bottom opening **40** each defined by the walls **20***a-b* and **22***a-b*. The joined walls and flanges of adapter **10** may be integrally joined or joined by a process such as welding.

As shown in FIG. **7**, vacuum openings **42***a* and **42***b* are formed in side walls **17***a* and **17***b*, respectively. Vacuum conduits **44***a* and **44***b* are joined with and extend outward from side walls **17***a* and **17***b*, respectively. Vacuum conduits **44***a* and **44***b* are in fluid communication with vacuum openings **42***a* and **42***b*, respectively. The first and second sets of walls **14** and **16** are spaced from each other to define a vacuum chamber **46** (FIGS. **7-9**) that is in fluid communication with each of the vacuum openings **42***a* and **42***b*. As shown in FIG. **1**, each of the vacuum conduits **44***a* and **44***b* has a circular outer flange **48***a* and **48***b*, respectively, that is configured to engage a vacuum system for drawing material from the vacuum chamber **46** through the vacuum openings **42***a* and **42***b* and vacuum conduits **44***a* and **44***b*.

The adapter **10** is joined with the frame **50** (FIG. **10**) of hopper car gate **12**. The hopper car gate frame **50** includes opposed side walls **52***a* and **52***b* each joined with opposed end walls **54***a* and **54***b*. The side and end walls **52***a-b*, **54***a-b* define a top opening **56** and a bottom opening **58** of the gate **12**. Walls **52***a-b* and **54***a-b* have an upper edge **60** that is joined with a flange or upper surface **62** and a lower edge **61** adjacent opening **58**. Flange **62** has a plurality of openings **64** that are aligned with openings in flange **30** for receiving fasteners **66** (FIG. **2**) to join the adapter **10** to the gate **12**. The dimensions of the flange **30** on adapter **10** may be varied depending on the type of hopper car gate **12** to which the adapter is mounted. As shown in FIG. **7**, walls **52***a* and **52***b* are substantially parallel to walls **20***a* and **20***b*, and as shown in FIG. **9**, walls **54***a* and **54***b* are substantially parallel to walls **22***a* and **22***b*.

Walls **52***a* and **52***b* (FIG. **10**) are joined with frame members **68***a* and **68***b*, respectively, and wall **54***a* is joined with frame member **70***a* (FIG. **6**). Frame members **68***a* and **68***b* are joined with frame member **70***a*. Another frame member **70***b* (FIG. **6**) is joined with frame members **68***a* and **68***b* underneath wall **54***b* (FIG. **10**). Three rails **72***a*, **72***b*, and **72***c* (FIG. **6**) extend between and are joined with frame members **70***a* and **70***b*. The rails **72***a*-**72***c* support a door **74**.

Door **74** is moveable between open and closed positions for allowing gravity discharge of material through the adapter **10** and gate **12**. In the open position, door **74** allows cargo to exit through bottom opening **58** (FIG. **10**) and in the closed position, door **74** blocks bottom opening **58**. As shown in FIG. **6**, two racks **76***a* and **76***b* are mounted to the bottom surface of door **74**. The racks **76***a* and **76***b* engage pinions **78***a* and **78***b* mounted on a shaft **80**. Shaft **80** rotates within and is supported by bearings **82***a* and **82***b* (FIG. **8**) positioned within sleeves **84***a* and **84***b* that are joined to frame members **68***a* and **68***b*, respectively. Sockets **86***a* and **86***b* are joined to the outer ends of shaft **80** for engaging a tool to rotate shaft **80**. As shaft **80** rotates, pinions **78***a* and **78***b* engage racks **76***a* and **76***b* to move door **74** in a direction that is perpendicular to shaft **80**. A locking mechanism **88**, shown in FIG. **1**, is joined to and extends between frame members **68***a* and **68***b* for preventing unwanted motion of door **74**.

Referring to FIG. **1**, flange **26** has a plurality of holes **90** for receiving fasteners (not shown) to join the adapter **10** and gate **12** to a hopper car (not shown). Preferably, the hopper car has a plurality of hoppers for storing cargo. Each of the hoppers preferably has an opening at the bottom of the car and a rim surrounding the opening. The rim has a plurality of holes that align with the holes **90** in flange **26**. The aligned holes receive fasteners for joining the adapter **10** to the rim of the hopper car. With the adapter **10** and gate **12** joined to a cargo containing hopper car, the cargo fills the volume defined by second set of walls **16** and door **74**. The dimensions of flange **26** on adapter **10** may be varied depending on the type of hopper car to which the adapter **10** is mounted.

Referring to FIGS. **1** and **7**, the lower edge **34** of the second set of walls **16** is spaced above door **74** when the door **74** is in the closed position to present a gap **92** between the lower edge **34** and door **74**. The vertical height of gap **92**, or the vertical distance between lower edge **34** and door **74**, is approximately between 0 to 0.5 inches, and most preferably approximately 0.25 inches. It is also within the scope of the present invention for a seal or seals to be joined to the lower edge **34** of the second set of walls **16** between notches **36** in order to seal the gap **92** between lower edge **34** and door **74**. As shown in FIG. **7**, the bottom edges of the vacuum openings **42***a* and **42***b* are vertically spaced a distance H from the lower edge **34** and gap **92**. The distance H is preferably between approximately 1 to 4 inches, and is preferably at least one inch. The distance H prevents cargo from entering the vacuum conduits **44***a* and **44***b* while the hopper car to which the adapter **10** and gate **12** are joined is traveling.

When door **74** is in its closed position, as shown in FIG. **1**, a vacuum system joined to either or both of vacuum conduits **44***a* and **44***b* can draw the cargo that fills the volume between second set of walls **16** and door **74** through the notches **36** and the gap **92** into the vacuum chamber **46** between the first and second sets of walls **14** and **16**. From the vacuum chamber **46**, the vacuum system can draw the cargo through the vacuum openings **42***a* and **42***b* and vacuum conduits **44***a* and **44***b*. The dimensions and number of the notches **36** and the height of gap **92** may be varied depending on the type of cargo con-

tained by the hopper car to which the adapter **10** is joined and the type and capacity of the vacuum system being used.

Referring to FIG. **7**, the upper edge **60** of the walls **52***a-b* and **54***a-b* of frame **50** is aligned with the lower edge **28** of the first set of walls **14** when the adapter **10** and frame **50** are joined. Because walls **52***a-b* and **54***a-b* and walls **14** are aligned in this fashion when adapter **10** and frame **50** are joined, the walls **14**, **52***a-b* and **54***a-b* function in combination as a set of walls having an upper section (first set of walls **14**) and a lower section (walls **52***a-b* and **54***a-b*). The lower section (walls **52***a-b* and **54***a-b*) is positioned at an angle with respect to the upper section (first set of walls **14**).

Referring now to FIG. **11**, a hopper car gate according to another embodiment of the present invention is shown generally as **200**. Hopper car gate **200** functions in substantially the same manner as the combination of adapter **10** and gate **12** shown in FIG. **1** and described above. While adapter **10** is a separate component that bolts to a gravity discharge hopper car gate **12** to provide the gate **12** with vacuum discharge capability, hopper car gate **200** is designed as a single unit that has both gravity and vacuum discharge capability.

Referring to FIG. **20**, hopper car gate **200** includes a frame **202** having a first set of walls **204** defining a discharge opening **206**. The first set of walls **204** includes side walls **208***a* and **208***b*, shown in FIG. **17**, that are each joined with end walls **210***a* and **210***b*, shown in FIG. **19**. The first set of walls **204** has a lower edge **212** and an upper edge **214**. The first set of walls **204** has an upper section **215***a* that is substantially vertical and a lower section **215***b* that is positioned at an angle with respect to the upper section **215***a*. A flange **216** is joined to the upper edge **214** of the first set of walls **204**. A second set of walls **218** has a lower edge **220** and an upper edge **222** that is joined to a flange **224**. Flange **224** on the second set of walls **218** is joined to the flange **216** on the first set of walls **204** preferably by fasteners received by aligned openings in the flanges. The second set of walls **218** includes end walls **226***a* and **226***b* that are each joined with side walls **228***a* and **228***b*. Referring to FIG. **19**, there is an angle Y between the second set of walls **218** and the upper section **215***a* of the first set of walls **204**. The angle Y is preferably between approximately 30 to 60 degrees.

A plurality of notches **230** are formed in the lower edge **220** of walls **218**. As shown in FIG. **11**, there are three notches in each of end walls **226***a* and **226***b* and two notches in each of side walls **228***a* and **228***b*. It is within the scope of the invention for there to be more or less notches **230** than those shown in FIG. **11**. The notches **230** preferably have a height C of between approximately 0.5 to 3 inches, and a width D of between approximately 1 to 4 inches. The gate **200** has a top opening **232** defined by walls **218**. The joined walls and flanges of gate **200** may be integrally joined or joined by a process such as welding.

As shown in FIG. **17**, vacuum openings **234***a* and **234***b* are formed in side walls **208***a* and **208***b*, respectively. Vacuum conduits **236***a* and **236***b* are joined with and extend outward from side walls **208***a* and **208***b*, respectively. Vacuum conduits **236***a* and **236***b* are in fluid communication with vacuum openings **234***a* and **234***b*, respectively. The first and second sets of walls **204** and **218** are spaced from each other to define a vacuum chamber **238** (FIGS. **17-19**) that is in fluid communication with each of the vacuum openings **234***a* and **234***b*. As shown in FIG. **11**, each of the vacuum conduits **236***a* and **236***b* has a circular outer flange **240***a* and **240***b*, respectively, that is configured to engage a vacuum system for drawing material from the vacuum chamber **238** through the vacuum openings **234***a* and **234***b* and vacuum conduits **236***a* and **236***b*.

Referring to FIG. **16**, the frame **202** includes frame members **242***a* and **242***b* that are joined with walls **208***a* and **208***b* (FIG. **17**), respectively, and a frame member **244***a* that is joined with wall **210***a* (FIG. **20**). Frame members **242***a* and **242***b* are joined with frame member **244***a*. Another frame member **244***b* is joined with frame members **242***a* and **242***b* underneath wall **210***b*. Three rails **246***a*, **246***b*, and **246***c* extend between and are joined with frame members **244***a* and **244***b*. The rails **246***a*-**246***c* support a door **248**.

Door **248** is moveable between open and closed positions for allowing gravity discharge of material through gate **200**. In the open position, door **248** allows cargo to exit through bottom discharge opening **206** (FIG. **20**) and in the closed position, door **248** blocks bottom discharge opening **206**. As shown in FIG. **16**, two racks **250***a* and **250***b* are mounted to the bottom surface of door **248**. The racks **250***a* and **250***b* engage pinions **252***a* and **252***b* mounted on a shaft **254**. Shaft **254** rotates within and is supported by bearings **256***a* and **256***b* (FIG. **18**) positioned within sleeves **258***a* and **258***b* that are joined to frame members **242***a* and **242***b*, respectively. Sockets **260***a* and **260***b* are joined to the outer ends of shaft **254** for engaging a tool to rotate shaft **254**. As shaft **254** rotates, pinions **252***a* and **252***b* engage racks **250***a* and **250***b* to move door **248** in a direction that is perpendicular to shaft **254**. A locking mechanism **262**, shown in FIG. **11**, is joined to and extends between frame members **242***a* and **242***b* for preventing unwanted motion of door **248**.

Referring to FIG. **11**, flange **224** has a plurality of holes **264** for receiving fasteners (not shown) to join the gate **200** to a hopper car (not shown). Preferably, the hopper car has a plurality of hoppers for storing cargo. Each of the hoppers preferably has an opening at the bottom of the car and a rim surrounding the opening. The rim has a plurality of holes that align with the holes **264** in flange **224**. The aligned holes receive fasteners for joining the gate **200** to the rim of the hopper car. With the gate **200** joined to a cargo containing hopper car, the cargo fills the volume defined by second set of walls **218** and door **248**. The dimensions of flange **224** may be varied depending on the type of hopper car to which the gate **200** is mounted.

Referring to FIGS. **11** and **17**, the lower edge **220** of the second set of walls **218** is spaced above door **248** when the door **248** is in the closed position to present a gap **266** between the lower edge **220** and door **248**. The vertical height of gap **266**, or the vertical distance between lower edge **220** and door **248**, is approximately 0 to 0.5 inches, and most preferably approximately 0.25 inches. It is also within the scope of the present invention for a seal or seals to be joined to the lower edge **220** of the second set of walls **218** between notches **230** in order to seal the gap **266** between lower edge **220** and door **248**. As shown in FIG. **17**, the bottom edges of the vacuum openings **234***a* and **234***b* are vertically spaced a distance L from the lower edge **220** and gap **266**. The distance L is preferably between approximately 1 to 4 inches, and is preferably at least one inch. The distance L prevents cargo from entering the vacuum conduits **236***a* and **236***b* while the hopper car to which the gate **200** is joined is traveling.

When door **248** is in its closed position, as shown in FIG. **11**, a vacuum system joined to either or both of vacuum conduits **236***a* and **236***b* can draw the cargo that fills the volume between second set of walls **218** and door **248** through the notches **230** and the gap **266** into the vacuum chamber **238** between the first and second sets of walls **204** and **218**. From the vacuum chamber **238**, the vacuum system can draw the cargo through the vacuum openings **234***a* and **234***b* and vacuum conduits **236***a* and **236***b*. The dimensions and number of the notches **230** and the height of gap **266** may

be varied depending on the type of cargo contained by the hopper car to which the gate **200** is joined and the type and capacity of the vacuum system being used.

In operation, the adapter **10**, shown in FIGS. **1-10**, is first joined to gate **12** by aligning flange **30** (FIG. **10**) on adapter **10** with flange **62** on gate **12** and inserting fasteners through the aligned holes of the flanges **30** and **62**. Then, the flange **26** on adapter **10** is mounted to the rim surrounding a hopper discharge opening of a hopper car by inserting fasteners through aligned openings on the flange **26** and hopper rim. With the door **74** in its closed position, the hopper is filled with cargo. When the hopper car reaches its final destination, the cargo can be discharged through the adapter **10** and gate **12** by either vacuum or gravity discharge. To discharge the cargo through the adapter **10** and gate **12** by vacuum discharge, a vacuum system is coupled with one or both of the flanges **48***a* and **48***b* of vacuum conduits **44***a* and **44***b*. The vacuum system is powered on to draw cargo from the hopper through notches **36** and gap **92** into vacuum chamber **46** (FIG. **7**). From vacuum chamber **46**, the vacuum system draws the cargo through vacuum openings **42***a* and **42***b* and vacuum conduits **44***a* and **44***b*.

For gravity discharge of material through adapter **10** and gate **12**, door **74** is moved from its closed position to its open position by engaging one of sockets **86***a* and **86***b* with an opening tool and rotating the socket **86***a*, **86***b*. Rotation of one of sockets **86***a* and **86***b* causes shaft **80** and pinions **78***a* and **78***b* to rotate. As the pinions **78***a* and **78***b* rotate they engage racks **76***a* and **76***b* on the bottom of door **74** and cause the door **74** to move to its open position. With the door **74** in its open position, cargo contained within the hopper to which the adapter **10** and gate **12** are joined discharges through the bottom opening **58** (FIG. **10**) of the gate **12**.

Gate **200**, shown in FIGS. **11-20**, operates in a similar fashion as the combination of adapter **10** and gate **12**. First, the flange **224** on gate **200** is mounted to the rim surrounding a hopper discharge opening of a hopper car by inserting fasteners through aligned openings on the flange **224** and hopper rim. With the door **248** in its closed position, the hopper is filled with cargo. When the hopper car reaches its final destination, the cargo can be discharged through the gate **200** by either vacuum or gravity discharge. To discharge the cargo through gate **200** by vacuum discharge, a vacuum system is coupled with one or both of the flanges **240***a* and **240***b* of vacuum conduits **236***a* and **236***b*. The vacuum system is powered on to draw cargo from the hopper through notches **230** and gap **266** into vacuum chamber **238** (FIG. **17**). From vacuum chamber **238**, the vacuum system draws the cargo through vacuum openings **234***a* and **234***b* and vacuum conduits **236***a* and **236***b*.

For gravity discharge of material through gate **200**, door **248** is moved from its closed position to its open position by engaging one of sockets **260***a* and **260***b* with an opening tool and rotating the socket **260***a*, **260***b*. Rotation of one of sockets **260***a* and **260***b* causes shaft **254** and pinions **252***a* and **252***b* to rotate. As the pinions **252***a* and **252***b* rotate they engage racks **250***a* and **250***b* on the bottom of door **248** and cause the door **248** to move to its open position. With the door **248** in its open position, cargo contained within the hopper to which the gate **200** is joined discharges through the discharge opening **206** (FIG. **20**) of the gate **200**.

From the foregoing it will be seen that this invention is one well adapted to attain all ends and objectives herein-above set forth, together with the other advantages which are obvious and which are inherent to the invention.

Since many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matters herein set forth or shown in the accompanying drawings are to be interpreted as illustrative, and not in a limiting sense.

While specific embodiments have been shown and discussed, various modifications may of course be made, and the invention is not limited to the specific forms or arrangement of parts and steps described herein, except insofar as such limitations are included in the following claims. Further, it will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

What is claimed and desired to be secured by Letters Patent is as follows:

1. A hopper car gate for discharging cargo from a hopper car, said car comprising a hopper having an opening and a rim surrounding said opening, comprising:

a first set of walls comprising opposed side walls coupled with opposed end walls, wherein at least one vacuum opening is formed in one of said side or end walls, said first set of walls presenting top and bottom openings;

a rail extending between and coupled with said side or end walls adjacent said bottom opening;

a door supported on said rail and moveable between a closed position in which it blocks said bottom opening and an open position in which it allows cargo to exit through said bottom opening; and

a second set of walls comprising opposed side walls coupled with opposed end walls, said second set of walls comprising an upper edge and a lower edge that is at least partially spaced above said door when said door is in its closed position to present a gap between said lower edge and said door, said second set of walls coupled with said first set of walls to present a vacuum chamber positioned between said first and second sets of walls, said vacuum chamber in fluid communication with said vacuum opening.

2. The gate of claim **1**, wherein said first set of walls comprises an upper edge adjacent to said top opening that is coupled with said upper edge of said second set of walls.

3. The gate of claim **2**, wherein said second set of walls are positioned at an angle with respect to said first set of walls.

4. The gate of claim **3**, wherein the angle between said first and second sets of walls is between approximately 30 to 60 degrees.

5. The gate of claim **2**, further comprising a flange coupled with said upper edge of said first set of walls, said flange adapted to be joined to the rim of the car.

6. The gate of claim **1**, wherein said vacuum opening is positioned at least one inch above said gap.

7. The gate of claim **1**, further comprising a vacuum conduit in fluid communication with said vacuum opening, said conduit coupled with and extending from one of said side or end walls, said vacuum conduit operable to be engaged by a vacuum system for drawing cargo through said gap, said vacuum chamber, and said vacuum opening into said vacuum conduit when said door is in its closed position.

8. The gate of claim **1**, wherein said gap has a height of between approximately 0 to 0.5 inches.

9. The gate of claim **1**, wherein notches are formed in said lower edge of said second set of walls.

10. The gate of claim **1**, wherein said first set of walls comprises upper and lower sections, each of which having upper and lower edges, and further comprising:

first and second mating flanges, said first flange coupled with said upper edge of said lower section and said second flange coupled with said lower edge of said upper section; and

a third flange coupled with said upper edge of said upper section and with said upper edge of said second set of walls, said third flange adapted to be joined to the rim of the car.

11. The gate of claim **10**, wherein said vacuum opening is formed in said upper section of said first set of walls.

12. The gate of claim **10**, wherein said second set of walls and said lower section are positioned at an angle with respect to said upper section.

13. A vacuum adapter configured for mounting on a hopper car gate comprising a frame presenting a top opening, a bottom opening, and an upper surface surrounding said top opening; and a door supported by said frame and moveable between a closed position in which it blocks said bottom opening and an open position in which it allows cargo to exit through said bottom opening for discharging cargo from a hopper car, said adapter comprising:

a flange configured for mounting to said upper surface;

a first set of walls comprising upper and lower edges, said lower edge coupled with said flange, wherein at least one vacuum opening is formed in said first set of walls; and

a second set of walls comprising an upper edge coupled with said upper edge of said first set of walls and a lower edge that is at least partially spaced above said door when said door is in its closed position to present a gap between said lower edge and said door, wherein said second set of walls is positioned to define a vacuum chamber between said first and second sets of walls and said frame, said vacuum chamber in fluid communication with said vacuum opening.

14. The vacuum adapter of claim **13**, further comprising another flange coupled with said upper edge of said first set of walls, said other flange configured for mounting to a hopper car.

15. The vacuum adapter of claim **13**, wherein said second set of walls are positioned at an angle with respect to said first set of walls.

16. The vacuum adapter of claim **13**, wherein said vacuum opening is positioned at least one inch above said gap.

17. The vacuum adapter of claim **13**, further comprising a vacuum conduit in fluid communication with said vacuum opening, said conduit coupled with and extending from said first set of walls, said vacuum conduit operable to be engaged by a vacuum system for drawing cargo through said gap, said vacuum chamber, and said vacuum opening into said vacuum conduit when said door is in its closed position.

18. The vacuum adapter of claim **13**, wherein said gap has a height of between approximately 0 to 0.5 inches.

19. The vacuum adapter of claim **13**, wherein notches are formed in said lower edge of said second set of walls.

20. A hopper car gate, comprising:

a frame defining a discharge opening;

a door supported by said frame and moveable between a closed position in which it blocks said discharge opening and an open position in which it allows cargo to exit through said discharge opening; and

a set of walls comprising an upper edge coupled with an upper edge of said frame and a lower edge that is at least partially spaced above said door when said door is in its closed position to present a gap between said lower edge and said door, said set of walls being positioned to define a vacuum chamber between said set of walls and said frame, said vacuum chamber in fluid communication with a vacuum opening formed in said frame, and wherein said gap is in fluid communication with said vacuum chamber and said vacuum opening.

21. The gate of claim **20**, wherein said frame comprises opposed side walls coupled with opposed end walls and a flange that is adapted to be joined to a hopper car.

22. The gate of claim **20**, wherein said frame comprises a rail which supports said door.

23. The gate of claim **20**, wherein said frame comprises upper and lower sections, each of which having upper and lower edges, and further comprising:

first and second mating flanges, said first flange coupled with said upper edge of said lower section and said second flange coupled with said lower edge of said upper section; and

a third flange coupled with said upper edge of said upper section and with said upper edge of said set of walls, said third flange adapted to be joined to a hopper car.

24. The gate of claim **23**, wherein said vacuum opening is formed in said upper section of said frame.

25. The gate of claim **23**, wherein said set of walls and said lower section are positioned at an angle with respect to said upper section.

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